Laboratory Investigation of the Aerobic Biodegradation of Municipal Landfill Materials

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The purpose of this study is to measure rates of settling and biodegradation of municipal landfill materials in large laboratory-scale bioreactors. Three 55 gallon clear acrylic tanks have been fitted with pressure transducers, thermisters, neutron probe access tubes, and leachate and air injection and collection ports. Air can be injected into the bottom of the tanks, and gas vented out the top. Gas compositions are monitored at the top of the tanks with a LandTec gas analyzer. Leachate can be collected at the bottom of the tanks, recirculated, and sprinkled over the top of the refuse. A neutron probe is used to estimate average moisture content of the refuse. All tanks contain 10 cm of pea gravel at the bottom, overlain by a mixture of fresh waste materials consisting of 24% dry paper, 11% fresh food waste, 7% metal (5% steel, 2% aluminum), 8% glass, 7% plastic, 8% garden waste, 24% soil, and 11% miscellaneous building materials and wood by weight. The materials were crushed, chipped and broken into pieces on the order of 5-10 cm in size. Three different treatments are being applied to the tanks: (a) air injection with leachate recirculation and venting from the top, referred to as Tank A (Aerobic Wet); (b) dry with gas venting from the top, referred to as Tank B (Anaerobic Dry); (c) leachate recirculation with venting from the top, referred to as Tank C (Anaerobic Wet). Relative degradation rates between the tanks were monitored by CO_2 and CH_4 production rates. Tanks AW and NW absorbed 16 kg of water sprinkled on the top before producing leachate. This water was absorbed by the paper, which appears wet when viewed through the clear walls of the tank.

Over the test period Tank A has shown 26% settling, Tank B 11.1 % settling, and Tank C 18.5 % settling. Approximately 80% of the settling in Tank C occurred during the initial wetting phase compared with 50% in Tank A. The leachate in Tank A has maintained a pH of 7.8 and has shown low levels of all measured parameters (metals, nitrate, phosphate, and TOC). Tank B did not produce any leachate. Tank C has shown high levels of all measured parameters and has required buffering to adjust the pH to neutral levels. An observed rise in temperature and changes in gas composition in Tank A was consistent with rapid aerobic biodegradation. However, there was evidence that the addition of air and water caused rapid cooling. The tanks are insulated but temperature trends have largely paralleled the diurnal temperature variations in the laboratory. Respiration tests on Tank A showed a decrease in oxygen consumption rates over a period of 190 days in the aerobic tank. Live/Dead cell counts have also shown a decrease in biological activity over the same period. Neutron probe measurements have proven to be a reliable method for monitoring average moisture content within the tanks.

Ongoing work includes investigation of the effect of nutrient addition on the activity in Tank A and further investigation of the effect of moisture and air addition on biodegradation rates.